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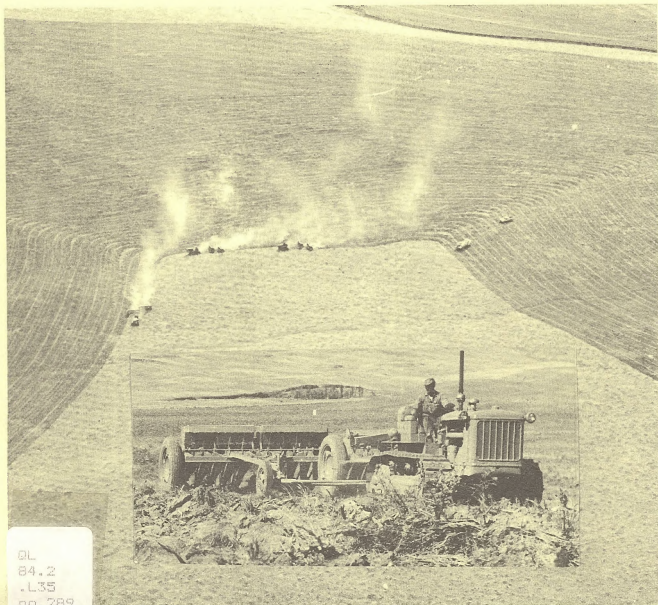
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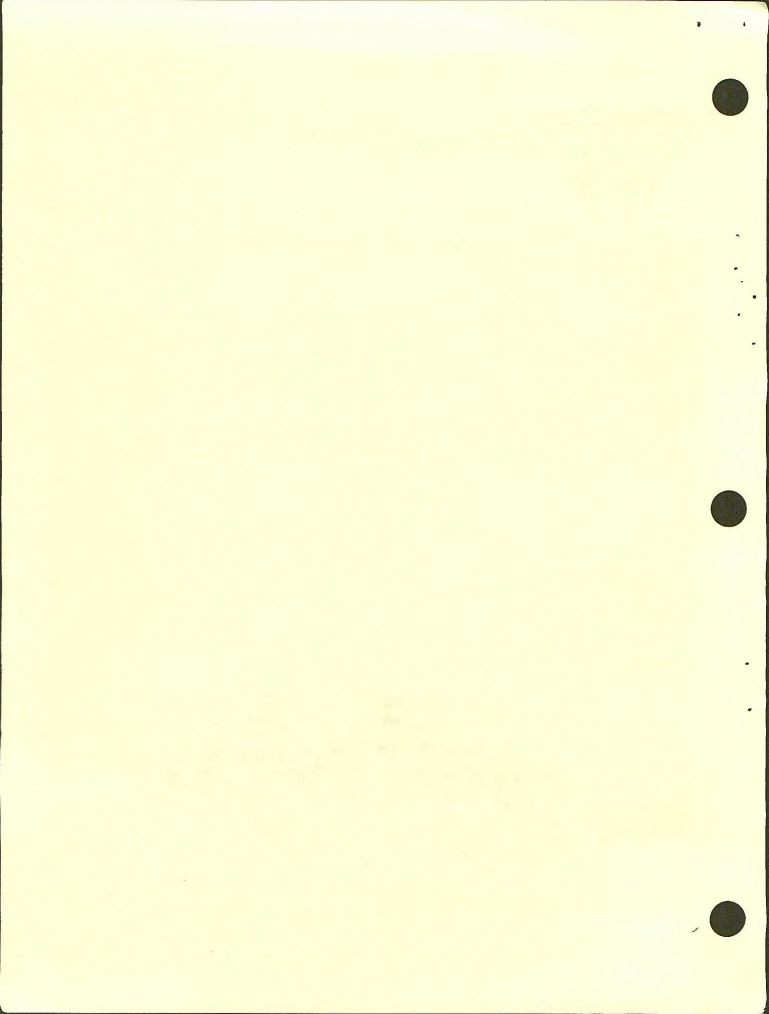


TECHNICAL NOTE

U.S. DEPARTMENT OF THE INTERIOR - BUREAU OF LAND MANAGEMENT
RANGELAND DRILL OPERATIONS



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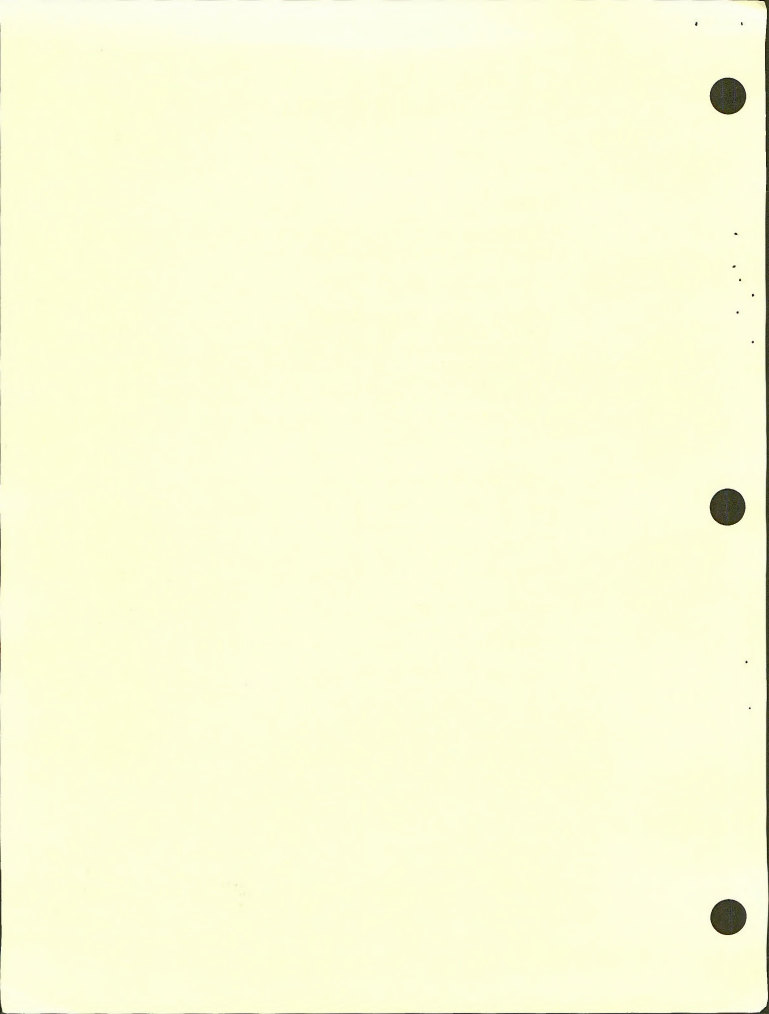
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PREFACE

The rangeland drill is an effective tool for seeding under wildland conditions encountered on most rangelands (Figure 1). Millions of acres of rangeland remain throughout the world which are in need of rehabilitation and improvement. It is anticipated that a large part of essential rehabilitation will be through seeding projects which will provide for improved management. The rangeland drill will continue to play an important part in this work in the United States.

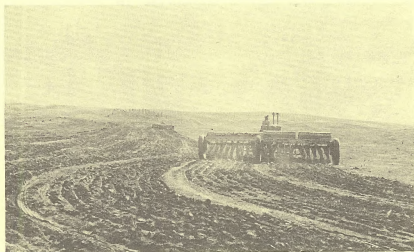


Figure 1. Drilling a burned-over area

Since 1950 when the original drill was conceived, there have been changes in drills along with the adoption of many improvements and modifications. This tech note is intended only to supplement instructions and procedures provided by the rangeland drill service manual and range seeding equipment handbooks. The primary purpose is to assist operators, work supervisors, shop personnel and others in the operation, maintenance and transportation of rangeland drills; and to identify and illustrate possible improvements and methods of repair.

GENERAL PURPOSE AND HISTORY

Early field experience proved that commercially available grain drills (Figure 2) designed for agricultural use were not suited to the adverse conditions normally associated with wildland seeding. To meet the needs of seeding operations under these conditions, it was necessary to develop a drill designed and structurally suited to operate on rough, rocky and often trashy terrain.

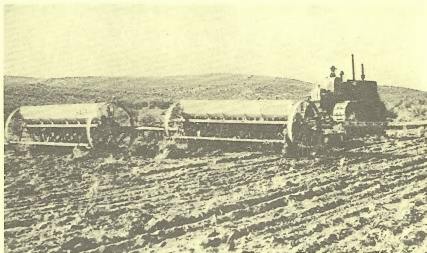


Figure 2. Grain drills failed to meet the needs of most rangeland seeding.

The forerunner of the rangeland drill was constructed by the Fremont National Forest in 1950 with a commercial grainbox and a reinforced frame on which were mounted large wheels and special disc arms. The disc arms were designed and mounted so they would swing up and out of the way when a rock or other object was encountered. The San Dimas Equipment Development Center, then at Arcadia, investigated the drill and in 1952 designed and fabricated a drill along the lines of the Fremont unit. Further modifications and refinements have since been made to increase efficiency and versatility.

The 1952 version is basically unchanged and considered the standard. Options that have been added are: grass seed attachment, fertilizer attachment, brush guard, steel wheels, 14 and 18 inch depth rings, land measurer, and, recently, adjustable-angle deep-furrowing disc arms.

SECTION I
DESCRIPTION OF FULL SIZE DRILL

DESCRIPTION OF FULL SIZE DRILL

All rangeland drills use John Deere Model B 20 x 6 or Model PD 10 x 6 grain boxes, feeds, drives, and related components. In 1960, John Deere changed from Model B to PD. Therefore, rangeland drills purchased prior to 1960 are designated as Model B, and those purchased in 1960 and later are Model PD. Each model is shown below and can be identified by two features:

1. The main grain boxes are closely joined at the center of the Model PD and spaced about 5 inches apart on the Model B (Figure 3).
2. The Model PD has a clutch and clutch throwout lever at each outer drive chain case. The Model B has a gear engagement and disengagement arrangement at each outer drive in place of a clutch (Figure 4).

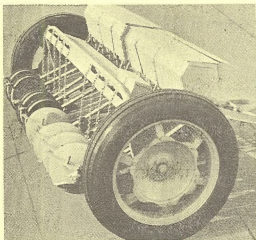


Figure 3. Model B

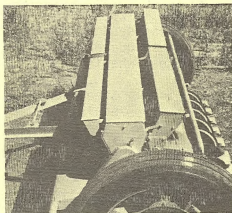


Figure 4. Model PD

The drill has a high-center frame for clearing obstacles and is mounted on two large wheels with pneumatic tires. The main frame is a heavily constructed, all-welded assembly. Older models have a fixed tongue or drawbar. Later models have a drawbar designed to fold back over the top of the feed box and lock to the rear frame member. The purpose of this feature is to facilitate transportation.

Two large seed boxes, or hoppers, are mounted on top of the main frame and have adjustable flute feeds with seed agitators. The hoppers, including the feed systems, clutches, and most of the drive mechanisms, are modified for adaptation to the rangeland drill.

Two groups of five disc opener arms are arranged to cast soil toward the drill center and equalize disc thrust. The disc arms are spaced 12 inches apart and attach to the front, main-frame, cross-member with hinge pins to allow independent vertical action when passing over rocks, brush, and other obstructions. Guards on the underside and in front of the disc minimize brush clogging. An 18-inch depth ring controls seed planting depth; and spindles are provided for adding weights to increase disc penetration when depth rings are not used. Seed row spacing is 12 inches for a total effective seeding width of 10 feet.

Chains hold the disc opener arms in raised position for roading and prevent swinging forward in lowered position. They are not intended to control depth of planting.

UNIT WEIGHTS (Approximate)

Standard unit with grain boxes and pneumatic tire wheels . . . 3650 lbs.

Add for optional attachments and accessories:

Fertilizer attachment	380 lbs.
Grass seed attachment	90 lbs.
Brush guard attachment	135 lbs.
Steel wheels	490 lbs.

Note: Steel wheels and pneumatic tire wheels are about equivalent in weight.

DIMENSIONS (Approximate)

Overall width	13'- 8"
Overall length, rear of disc arms to tip of tongue	9'- 9"
Overall length, rear of disc arms to tip of ball hitch	11'- 0"
Overall length, tongue folded back	5'- 2"
Overall height, tongue in operating position	5'- 9"

DESCRIPTION OF HALF-SIZE DRILL

The standard half-size drill is essentially half the full size unit, with a single grain box. The feed mechanism is driven from the left wheel only (Figure 5).

A group of five disc opener arms cast the soil in one direction. Seed row spacing is 12 inches and the total effective seeding width is 5 feet. With the exception of the brush guard, all optional accessories are adaptable to this unit.

UNIT WEIGHTS (Approximate)

Standard unit with grain box and pneumatic tire wheels2100 lbs.

Add for optional attachments and accessories:

Fertilizer attachment	190 lbs.
Grass seed attachment	45 lbs.
Steel wheels	490 lbs.

DIMENSIONS (Approximate)

Overall width 8' - 1"

All other dimensions are identical to those of the full size unit.

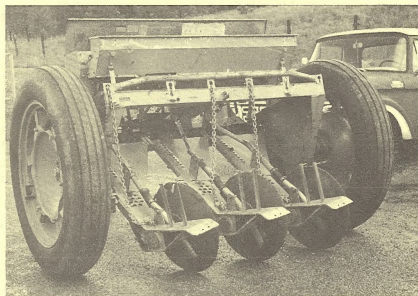


Figure 5. Half-size drill with adjustable-angle disc arm

SECTION II RANGELAND DRILL OPERATING HINTS

The operation of the rangeland drill is a very important part of the success or failure of any seeding job. Since seeding is an expensive undertaking, it is essential that actual seeding operations be done properly. The operation and maintenance of the drills must be watched to prevent malfunctions which can result in no seed being applied, uneven distribution of seed or too much seed being applied. Depth of planting must also be checked. The speed of operation is very important. Moving too fast will result in bouncing of the drill, uneven distribution and poor coverage. A well trained operator is essential to the success of any seeding.

A. General Operating Hints

1. Before field use:

- a. Be certain you are familiar with the rangeland drill. Study the San Dimas Equipment Center's Instruction Manual to become familiar with intended use and all phases of lubrication, service and maintenance requirements.
- b. Adjust hitches so that drills ride level when towed.
- c. Thoroughly check drill to see that all pins, bolts and adjustments are secure, and that it is completely lubricated with the proper lubricants.
- d. Determine intended direction of turn. This may vary with different hitches or drill carts. Improper turning may cause severe damage.
- e. Be sure the seeding mechanism including agitator assembly, seed feeds and seed tubes is clean and operating freely before filling hoppers. This is particularly important to prevent breakage when the drill has been in storage or in wet freezing weather. Proper operation can be determined by:
 - (1) Jacking up and turning the wheels with drill in gear. Steady jacks - block also before climbing under drill.
 - (2) Using a wrench to rotate the square feed shaft located under the seed hoppers in either direction with the drill out of gear.

2. Field operations:

- a. When possible, seed on the contour to reduce surface runoff and erosion. This also is much easier on the equipment.

- b. Use clean seed. If bearded varieties are to be sown, they should be run through a hammer mill and cleaned to prevent clogging of seed feeds and tubes.
 - c. Check seed feed openings and seed tubes frequently. Be sure these are clean, open and free of trash or other foreign objects.
 - d. Lubricate with proper lubricant at regular intervals. A good practice is to lubricate at noon and upon quitting when everything is warm, rather than prior to starting work in the morning. During longer days (12 to 14 hours), three lubes may be necessary.
- B. Common Problem Areas Resulting in High Repair Costs, Excessive Down Time and/or Poor Seeding Operations

1. Operation

a. Speed

Pull drills two to four miles per hour. Decrease speed in rough going or when obstructions are encountered. Pulling the drills at double the recommended speed generally results in at least three times the maintenance and repair costs; and where obstructions exist such as rocks, brush, etc., "skips" will occur resulting in a poor seeding. During cold weather, considerations should be given to reducing drill speed to two miles per hour. Higher speed or frozen ground increases the rate of breakage to equipment.

b. Use of Disc-Arm Assembly Chains

These chains have two functions:

- (1) Raising and holding the disc arms during transportation in the field.
- (2) Preventing the disc arm from dropping and allowing the flexible seed tube to be pulled out of the metal seed tube. When the drill is in operation, the chain should be fully extended and firmly attached to the disc arm and to the drill frame.

c. Moving Drills in the Field

The disc arms must be securely chained up, the feed mechanism taken out of gear, weights must be removed and drags must be removed or wired up. Excessive speed or hard bumps may break the chains and let the arms fall.

On drills with the modified, heavy, adjustable arms, additional or heavier arm chains must be used. Particular care must be exercised when moving these drills to prevent frame breakage or damage.

d. Backing drills

Drills must not be backed while attached to a drill cart as it is impossible to control them. Breakage will occur or one drill backs over the other, bending the box. If limited backing is necessary such as in loading or when stuck, the drills must be backed separately. The arms must be raised to prevent plugging seed tubes, drags laid across arms to prevent breakage or loss, and the feed mechanism disengaged to prevent breakage. Never back any drill or vehicle until absolutely sure there is no object, other vehicle, or person behind or have spotter to direct backing operations.

e. Crossing Deep Draws

When crossing draws, speed must be reduced. The operation must watch for:

- (1) The change of angle caused by the cart coming out of the draw with the drill still in it causes a prying action between the cart and the tongue. This often causes breakage or damage to the hitch.
- (2) If the disc arm drops rapidly into the draw without hitting the bottom, the arm chain will frequently break and let the seed tube pull out.

Much of this problem is reduced when drilling is done on the contour.

f. Wearing of Disc and Disc-Opener Shaft

If the bearing is loose or worn, the shaft will wear. If the disc is loose, the shaft and the hole in the disc will wear. When depth bands are not used, use a spacer washer to permit tightening the nut that holds the disc on the shaft. Make sure this nut stays tight and the snap ring stays in place. Rocks catching between the arms can dislodge either.

- g. All nuts and bolts must be kept tight. Any looseness will cause holes to wear oblong, bolts to shear, nuts to come off, and ultimate and maybe serious breakage or damage.

h. Lost Drags

If the operator watches, most drags that are lost can be picked up on the next round.

i. Cleaning Seed Boxes

Upon completion of drilling operations, clean the seed boxes and seed feeds thoroughly. Scoop out and resack seed left in boxes; then set the feed adjustment wide open and pull the drills until empty of seed.

Seed left in drills will mold and sprout over winter and is extremely difficult to clean out. The accumulated material will draw and hold moisture and cause rust.

Occasionally fertilizers are used in the drill boxes. These are highly corrosive. Without prompt and thorough cleaning of the seed boxes, drill flutes and seed tube openings, much damage will result, and expensive repairs and replacements will be necessary. Caution must be used around fertilizers. Check for any protective devices such as eye protectors or respirators.

- j. Finally - preventive maintenance, coupled with good observation of the equipment, will greatly reduce maintenance and repair costs. Even more important is the prevention of down time. Not only is this a dollar savings, but, due to the normal critical timing on seeding jobs, it could mean the difference between success and failure of the seeding or project completion.

2. Faulty or Inadequate Field Repairs

- a. DO NOT weld the snap ring to the disc opener shaft. Any subsequent repair generally requires replacing the shaft, one of the major expenses in drill repair.

The snap rings, if properly installed and checked regularly, will adequately keep the shaft in place. The ring has to be properly installed so as not to distort its tension. It can be installed easily and quickly by driving it over the end of the shaft with a home-made tool such as a short piece of pipe with an inside diameter that will just fit over the outside of the shaft.

Use the correct snap ring. Original shafts had round snap ring grooves, later ones have square-sided grooves. The snap rings do their job well when the right ones are properly installed in their respective grooves.

- b. DO NOT weld seed tubes to the disc arm assemblies. In making the repairs to bring the drill back to standard, it is necessary to replace the seed tube. Cutting and welding on the arm assembly weakens it and often misalignment occurs. This causes further damage to other parts.
- c. DO NOT weld the arm pins to the anchor blocks on the drill frame. These are specially constructed pins, locked in place by a 3/8" x 3 1/2" bolt. When these have to be cut out with a torch, it is sometimes necessary to replace the anchor block on the frame. This is a time-consuming and expensive operation.
- d. DO NOT use under-size pins in place of the original arm pins. The slack causes wear on the anchor blocks. These will then have to be replaced.
- e. DO NOT weld drive gears and clutch together. This makes it impossible to throw the drive mechanism out of gear or let the ranchet work properly when the drill is backed.
- f. In the event of any breakage in the frame, assure correct alignment before repairing. Improper alignment causes additional wear, breakage and repair costs.
- g. Use safe welding and/or burning equipment and proper personal protective equipment.
- h. Flashbacks - burned hoses - proper clamps - gages and glass.
- i. Do not store reserves of oxygen and acetylene together.
- j. Do not use the compressed oxygen gas for cleaning dust or other foreign substances from clothing. Clothes will absorb oxygen and any contact with flames will result in immediate explosion.
- k. Keep oily rags, grease, etc. away from oxygen. Fire extinguishers shall be at the location of any welding or cutting.

C. Drill Drags and Seed Coverage

Under most seeding situations, it is advisable to use some type of drag behind the disc arm assembly to cover seed.

There are basically two types of drags - the chain drag and the pipe drag. There are several variations of each. Each of the two types has a different function (Figure 6 and Figure 7).

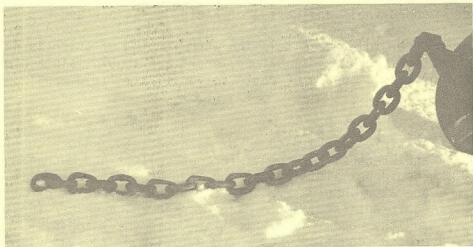


Figure 6. Chain drag

These vary in length and weight. The norm is probably a 4-foot length of 1/2 inch diameter link chain.

The only purpose of the chain is to get seed coverage. It is normally used with shallow furrows where no soil compaction is desired. In deep-furrow drilling operation, the chain drag often covers seed deeper than recommended.

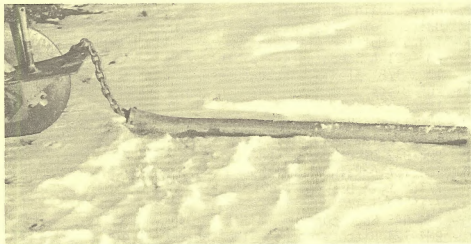


Figure 7. Pipe drag

These are made of 2" pipe, generally 42 to 48 inches long, bent up about 30 degrees on one end where attached to the disc arm. These are intended for use in deep-furrow drilling to compact the furrow walls to prevent sloughing and too deep coverage of the seed, and to cover the seed in a shallow, compacted layer in the bottom of the furrow. The pipe drag works very well when seeding is in plowed ground.

D. Recommended Tools and Parts for Field Operations and Repairs

1. In order to prevent delaying work (timing of which is normally critical because of weather) operators should maintain adequate tools and a supply of parts to facilitate field repair of drills.

a. Tools

A fairly complete tool box with sockets, snap ring pliers, end wrenches, crescent wrenches, pliers and mechanic's hammer should be maintained at the seeding site. In addition, the operator should have a five foot bar, aligning bar, lifting equipment (at least a handy man jack), a welder (Caution) and the necessary lubrication equipment. Tools must be in proper condition. Do not use faulty or loose tools - do not use chisels with mushroomed heads. Any portable electric tools must be either three-wire grounded or of double insulation.

2. Suggested items for emergency field repairs on drills (based on 4-6 drills).

These items should be kept at the project site:

- 12 - 3/8" x 4" standard bolts with nuts and lock washers
- 4 - RM4-053 Pin 4-3/4"
- 1 - RM4-053 Pin 3-1/2"
- 6 - Snap rings - square
- 2 - Drive chain master links
- 2 - Drive chain 1/2 links
- 6 - 1-3/4" Muffler clamps
- 2 - RM2-021-A Seed tubes - plain
- 6 - 1" x 1/8" Flexible seed tubes
- 2 - 20" Discs
- 6 - 1" Castle nuts
- 6 - 1" Flat washers
- 6 - 1-1/8" Flat washers
- 2 - RM4-042 Disc opener shafts
- 2 - TCJ 15/16 Fafnir bearings
- 6 - 7/16" x 1" USS cap screws
- 12 - 7/16" x 1-1/2" USS cap screws
- 1 - RM4-045 Seed cap
- 1 - RM4-124 Hitch - socket (Not needed if drills equipped with
- 2 - RM4-061 Hitch - link the new universal hitch)
- 10 - Drags, with chain, swivels and bolts
- 1 - Tire and wheel for drill and for cart

An assortment of bar iron of various sizes for repairing and reinforcing breaks. An assortment of cotter keys, bolts, nuts and grease fittings (same size and type as original). It is recommended to have some 3/8 inch fence stays on hand to clean seed tubes with. They are twisted and will clean much better than straight wire.

"Large repair jobs and overhauls should be done by experienced mechanics only."

SECTION III MODIFICATIONS AND IMPROVEMENTS

1. Replace original seed tube assembly - Part No. RM4-02-01 with plain seed tube - Part No. RM2-041-A. This seed tube is installed over the disc opener shaft instead of under the shaft as the original seed tube is mounted. This is accomplished by using two extension brackets to which the seed tube is attached by two muffler clamps. Figure 8.

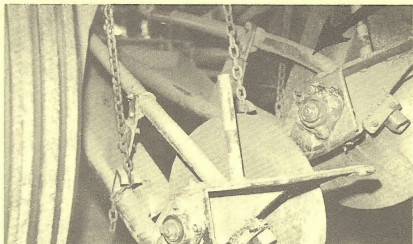


Figure 8. New seed tube attached

When operating in wet soils or in snow, the original tube with the shoe close to the disc and to the soil surface frequently plugs with mud or snow and ice. When the drill is backed for any reason the tubes become plugged.

In addition to reducing wear and breakage from rocks, this modification has another good feature. The seed falls higher on the disc and is distributed from the original soil surface to the bottom of the furrow. The principle here is that some of the seed will be in the most advantageous placement. With large variations in soil texture, structure and chemical composition, and with wind sometimes blowing furrows full, some of the seed can still germinate and become established.

2. Reposition the grease fitting on the disc opener shaft housing to align with the center of the Torrington bearing, Part No. 24282. This is done by drilling and tapping a hole to accept a 1/8 inch zerk fitting, aligned with the center of the Torrington bearing. When reassembling the Torrington bearing in the shaft housing, it is necessary to make sure the grease hole in the bearing is directly under the repositioned grease zerk fitting. Install a 1/8 inch pipe plug where the original zerk was (Figure 9).

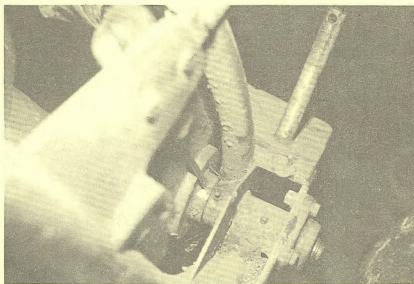
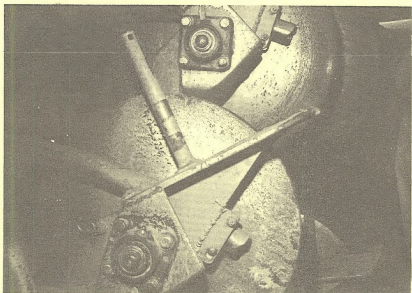


Figure 9. Repositioned grease fitting on disc opener shaft housing, aligned with Torrington bearing

The original position of this zerk fitting required filling the entire housing with grease before any would be forced out through the Torrington bearing, and then only through areas of least resistance lubricating only a portion of the bearing surface. Now grease entering the bearing is channelled around the inside circumference of the Torrington bearing and is forced both ways to the outer edge of the bearing, giving complete surface lubrication. When this bearing is not properly lubricated, this causes rapid wear on the softer disc opener shaft.

3. Replace original F215 Linkbelt bearing on the disc opener assembly with TCJ 15/16 Fafnir Tri-Ply sealed bearing (Figure 10). The original impact bearing is poorly sealed which allows the entrance of dust and dirt. The abrasive action of the dirt quickly wears and ruins the felt seal causing a premature bearing failures. If not detected, this ruins the entire disc opener shaft assembly.



A.

B.

Figure 10. Fafnir Bearing (A), Linkbelt Bearing with grease fittings (B)

The Fafnir TCJ 15/16 replacement bearing is a permanently sealed, and very effective bearing that requires no further lubrication. The use of this bearing eliminates time required for frequent lubrication, plus the down time caused by the failure of the original bearing.

Some drills have been in use with this tri-ply sealed bearing since 1967 and have not had a single bearing failure to date. The original bearing, in abrasive soils, would often only last one normal season, even with proper lubrication.

4. Install a grease fitting in outboard bearing - Part No. RM4-11-3. This is done by drilling and tapping a hole in the center of the bearing to accommodate a 1/8 inch grease zerk fitting (Figure 11).

The factory installed bearing has no provisions for lubrication. The life of this bearing is increased many times by providing for and accomplishing proper lubrication.

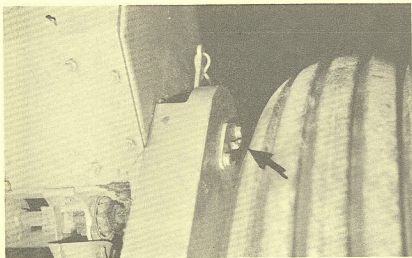


Figure 11. #4M Grease fitting installed in outboard bearing

5. Installation of seed box angle braces (Figure 12). These braces are installed from the top of the seed box support to the drill frame at the front center of the machine.

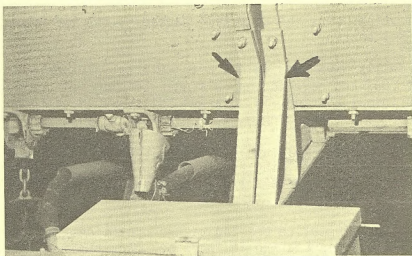


Figure 12. Seed box angle braces

This eliminates breakage at this point due to loaded seed boxes being subjected to severe stresses when drilling is on broken or rocky areas. Without these braces the seed box will break loose at the original braces causing misalignment and additional wear and breakage to other components.

6. Drill Tongue Reinforcement (Figure 13): (1) The tongue is reinforced on the inside of the angle iron frame with a $1/2$ " to 2" x 48" fitted, flat, steel bar. Drill a 1" hole in one end of the bar and install it over the existing 1" bolt at the back of the tongue assembly. This will require a longer bolt. The reinforcing bar is then stagger-welded in 2" welds at 6" intervals. (2) Fit and weld a $1/2$ " x 2" flat iron bar on a 45° angle between the upright iron at the rear of the tongue assembly and the angle iron used for the tongue assembly.

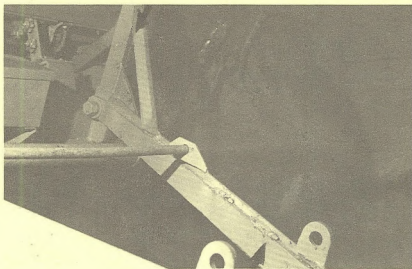


Figure 13. Tongue reinforcement

7. Weld weight peg extensions on existing pegs to provide a wider range of weight for varied drilling conditions (Figure 14).

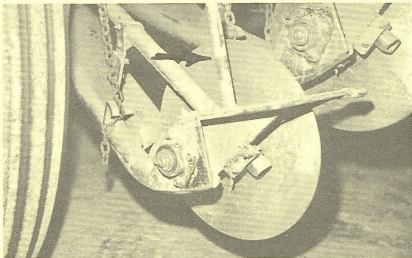


Figure 14. Weight peg extension

8. Reinforce rims and wheel spokes where needed (Figure 15) and weld on valve stem protector to prevent damage from rocks or brush (Figure 16).

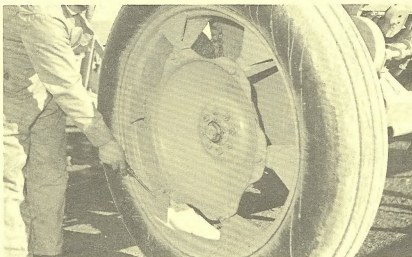


Figure 15. Spoke and wheel reinforcement



Figure 16. Valve stem protector

9. Cut a hole in the bottom of the chain guards to let dirt and brush work out and to let snow and water out (Figure 17). This presents trouble with this freezing and breaking the chain when starting on cold mornings.

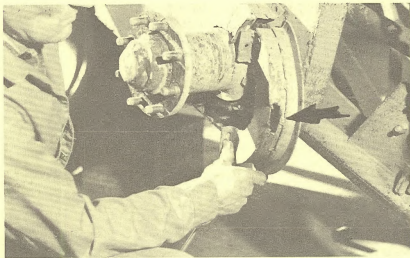


Figure 17. Hole cut in bottom of chain guard for self cleaning

10. Welding the property number on the rear of the drill frame is a good practice (Figure 18). This makes for continued, positive identification, whereas the property number tag or painted numbers can easily be lost or obliterated. Drills are frequently loaned among or between agencies, and positive identification is a must.

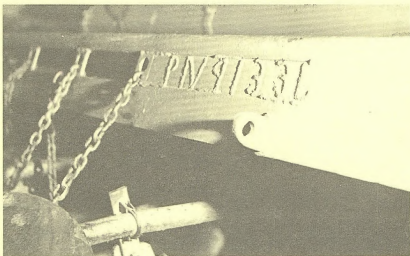


Figure 18. Property number

11. On PD drills, remove pipe plug in bottom of gear case and replace with pipe reducer and 1/8" grease zerk fitting (Figure 19). Then use chassis lube instead of 90 weight gear oil because these gear boxes were not properly designed to retain 90 weight gear oil.

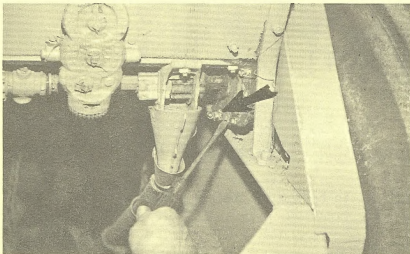


Figure 19. Grease fitting installed in bottom of gear case on PD drill

12. Replace plastic or gum rubber seed tubing with more flexible, tougher, and more weather resistant vinyl tubing.
13. After final repairs are complete, clean, prime and paint the equipment as needed.
14. Seeding rate reduction modifications can be accomplished by changing one sprocket and adding three links in the drive chain reducing the drill rolls rate by 33 percent. Another modification is described in Appendix 1.
15. For possible modifications of fertilizer attachments, see Appendix 2.

SECTION IV RANGELAND DRILL HITCH MODIFICATIONS

Because of problems associated with hitch breakage and subsequent down time, a replacement hitch was developed as a standard for Bureau of Land Management Districts. It is more versatile, sturdier, and less subject to breakage than previous hitches.

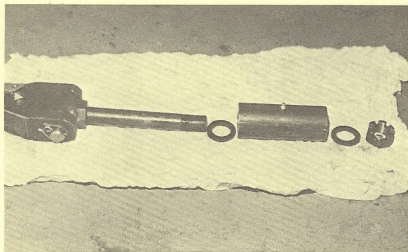


Figure 20. Disassembled Universal Hitch

Drills with this hitch can be used singly with a wheeled or small crawler tractor, or in multiples with drill carts that have been modified to accept the hitch. The bulldog hitch currently used on recently acquired drills has severe limitations. It isn't sturdy enough to prevent breakage when used in rough country. The Universal hitch allows freedom of movement in rough terrain.

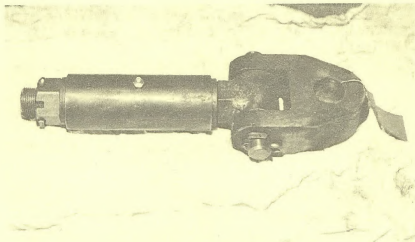


Figure 21. Assembled Universal hitch, note grease zerk for lubrication of pin and busings

Further details and drawings on the Universal hitch may be obtained by writing the Bureau of Land Management District Manager, P. O. Box 700, Vale, OR 97918.

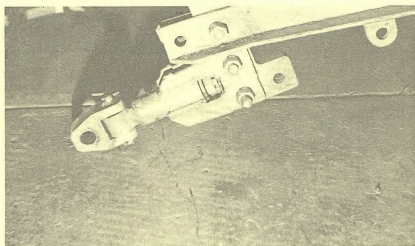


Figure 22. Universal hitch welded in Bulldog hitch assembly plate

SECTION V TRACTOR REQUIREMENTS

Large wheeled tractors with large tires can be used adequately for some drilling operation; but their use should be limited to level, rock-free sites during good drilling weather. Adequate traction is

a problem with wheeled tractors unless extra wide tires are used. When using this type equipment, adequate specifications regarding use, and frequent inspections are necessary. Many operators seem to have difficulty in maintaining reduced speeds when using this type draft equipment. Since this equipment is prone to get stuck resulting in attempts to back the drills, breakage is common.

Depending on terrain and soil conditions, crawler tractors will do a much better job with less breakage of drills and subsequent down time than when wheeled tractors are used.

Because range seeding in the United States is usually on rolling to broken terrain, crawler tractors with a power reserve are recommended.

The following recommendations may vary slightly with the conditions of terrain, soils and vegetative cover:

1. Single drill units should be towed by crawler tractors equivalent to the Caterpillar D-4.
2. Double drill units should be towed by crawler tractors equivalent to the Caterpillar D-6.
3. Units of three should be towed by crawler tractors equivalent to the Caterpillar D-7.
4. See safety requirements for all tractors.

SECTION VI STORAGE

When storing drills, clean (steam cleaning is a good way), and grease all moving, earthworking and other exposed parts to prevent rust. Indoor storage is recommended. If stored outdoors, the machine should be completely covered with canvas or equal.

Clean all seed from the seed box as seed will mold and cause damage to the seed feeds and hopper. After all seed has been removed from the box, clean the box and seeding assembly with diesel oil or kerosene. This eliminates rust and sticking over long storage periods. Any air used for cleaning must be reduced to 30 psi at the dead end and eye protection must be worn.

Disengage feed drive. If drive shafts become corroded or frozen and the drill is moved, breakage of gear housing can occur.

SECTION VII
SAFETY

Safety is everyone's responsibility and must always be the prime consideration in any job. If accidents involving property damage, lost time, and human suffering are to be avoided, the person in charge of the drilling operations should analyze the equipment to be used, determine the hazards connected with its operation, and always instruct and orient the operators in its safe and proper use. If you, the supervisor, are in doubt or are unsure, get expert help. Accidents, especially those involving personal injury or loss of life, can't be recalled.

Safety codes and/or safety handbooks, where available, should be made a part of every job. Suggestions to be considered in the safety planning in every job include:

1. Insofar as possible, use only experienced operators.
2. Keep the machinery clean, well lubricated, and in first class operating condition. Accidents are much more frequent with equipment in poor condition, or equipment not maintained properly.
3. Study, understand and follow operating instructions.
4. Never work directly under hoisted equipment even if only a disc arm assembly. Properly block at all times.
5. Use the proper and safe method of lifting. Lifting equipment must be adequate and properly used for the particular job, be it human or machine.
6. Never grease or repair any equipment while it is in motion.
7. Never jump off a machine. Climb down. Use hand-holds on machinery.
8. Never mount moving equipment or dismount from it.
9. Frequently check hitches and other equipment that are subject to frequent and heavy strain.
10. When using equipment on slopes, plan ahead for safety. Side hills are dangerous. Tractors and drills can tip over, especially if the ground surface is frosted or covered with ice or snow. All tractors used for such operations must be equipped with ROPs and provided with seat belts.

11. Before drills are unhooked from the tractor or drill cart, loosen chains and let disc arm assemblies down. This will prevent sudden upending of drill and possible injury to persons or equipment.
12. When roading drills on a road or highway, use a "Slow Moving Vehicle" emblem. In addition to conforming with the law in many states and OSHA, this is only using common sense.
13. Never smoke in the vicinity of flammable fuels or other material. Band and ground all fueling units and containers. Post readily visible "no smoking" signs.
14. Keep tractor(s) in good mechanical shape. Check tracks, undercarriage, brakes, steering apparatus, lights and other safety items frequently. All tractors with obstructed view to the rear will have reverse signal alarm audible above the surrounding noise level, or a spotter to help back vehicle at all times. Tractors shall be provided with horns in operable condition.
15. Remember - Speed can kill. Doubling tractor speed increases overturning chances by four times.
16. Apply brakes slowly to keep from overturning. Always check brakes every morning prior to any use.
17. Slow down before turning. Always operate at moderate speed. When in doubt--slow down.
18. Use care on steep, rough or uneven ground.
19. Tractors and other pulling units should only be operated with roll-over protection systems and seat belts provided and used.
20. Never permit riders on the tractor or towed equipment.
21. Don't overload equipment as power needed for control is lost.
22. Shut off motor before checking, cleaning or adjusting.
23. Guard V-belts, pulleys, chains, sprockets, items of danger such as hot mufflers and other exposed and moving parts from accidental contact.
24. When guards are removed for repairs, replace them before the machinery or equipment is put back into operation.
25. Never remove radiator caps without adequate equipment to smother steam and to protect from scalding.

26. Use goggles in severe dust conditions.
27. Cab glass will not be broken, cracked or distorted but must be replaced prior to use of equipment.
28. Brakes, and other controls, will be covered from weather conditions or against possible entry and loss of use by snow, ice or debris.
29. Fire extinguishers shall be mounted on all equipment used for pulling drills.
30. "Safety" training is a must for all personnel before they become active in any job.
31. Last but not least, check safety codes pertaining to the type of work you are about to carry out.

SECTION VIII DRILL CALIBRATION

After presetting for desired seeding rates, all drills require calibration to insure desired seeding rates are achieved. Seed size, weight, mixture and dryness as well as degree of processing and amount of trash present affect seeding rates.

Items of importance to calibration are:

1. Calibration must take into consideration both known percentages of live, pure seed and germination, as determined by seed testing. Seed can be tested at one of the Seed Testing Laboratories.

Most old seed will have to be seeded at a heavier rate to compensate for a decrease in germination.

2. Calibrate by seed lot and source. Seed from different lots, even though the same species, may have large variations in size and/or weight. Both cause changes in the rate of seeding.

There are a number of methods of calibrating drills for seeding a given number of pounds of seed per acre. The following methods are recommended:

No. 1.

Run the drill over a canvas or firm surface with the drill in gear. Count the number of seeds per row foot of any one of the species in the mixture. Base your count on the average of at least three, five-foot sections of drill row.

Compare the average number of seeds drilled with the number the desired seeding rate provides. Be sure to take into account the particular row spacing being used. Make the necessary adjustments in the drill setting and repeat the operation until the desired seeding rate is obtained.

No. 2.

Calibration in the shop - Jack up and block the drill so that the wheels turn freely and place a canvas under the seed tubes. Fill the hopper with the desired seed mix and set the seed regulator at the desired drilling rate. Rotate the wheel until the land measurer registers the predetermined acreage to be covered in the trial. Gather and weigh the seed collected from the canvas, calculate rate per acre and adjust feed rate accordingly. As a double check on the land measurer, (these frequently are, or become, inaccurate) you could count the revolutions, and multiply by wheel circumference to determine area. Seed can also be caught in pans or bags.

No. 3.

Since the vibration of drills and seed tubes in the field affect rate of seeding, it is preferable to calibrate in the field under typical use conditions including speed of travel.

In the field, seed a predetermined small acreage using either measured area or lineal drill seeding length converted to acres. Determine amount of seed used and adjust until desired rate is obtained.

The following formula can be used in calibrating a drill in the field:

Lbs. per acre of seed planted = $\frac{43,560 \times \text{lbs. seed collected}}{\text{Drill width in ft.} \times \text{strip length in ft.}}$

A good rule of thumb is one set of drills will use about a sack (50 pounds) of crested wheatgrass seed an hour at three miles per hour. This will give approximately seven pounds per acre. Time would have to be adjusted if a different rate were desired.

When there is trouble in calibration of a drill, look at the slack in the feed roll cups and gate. Often this can be taken up. Loosen the nuts on the bottom of the cups and adjust the cups so that the rollers are all exposed the same distance.

SECTION IX
TRANSPORTATION OF DRILLS

Much damage to drills has been and is due to poor techniques of loading, hauling and unloading (Figure 23). Proper loading, unloading and securing methods will reduce damage (Figure 24).



Figure 23. Drills should be loaded with tongues offset and crossed, pointing towards each other.



Figure 24. Most highboy trailers will carry four drills.

Tilt bed trailers work well for one or two drills. Region 5 of the Forest Service has found the straddle type rangeland drill carrier to work satisfactorily. This was redesigned in 1970, current design is available from the San Dimas Equipment Development Center.

Drags, especially pipe drags, must be removed or wired securely back of the weight pegs when drills are transported. Drags can become lost when hanging over the edge of the truck.

A fork lift or mobile crane is recommended for loading drills. Figures 25 and 26 demonstrate methods of loading and unloading with the fork lift.



Figure 25. Proper balance of the drill on forklift is important

Safety blocks must be used on lift forks to position the drill and to prevent the drill discs from coming in contact with the mast of the fork lift. Also secure the drill with a chain from the drill tongue to the top of the mast of the fork lift which prevents the drill from tipping forward (Figure 26). Each drill for safety and proper positioning must be loaded and firmly chained down prior to removing fork lift bars. In unloading, only one drill at a time can be unchained from the truck, and then not until the fork lift bars are properly placed.

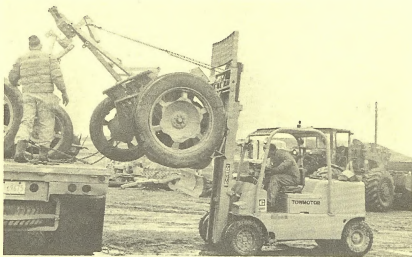


Figure 26. Note chain required to secure drill during loading and unloading.

Chaining down of drills when loaded must be over the frame or axle, never over seed boxes. A minimum of two chains per drill are required for safety (Figure 26). At intervals, while transporting, check the chains for tightness as the drills bouncing over the rubber tires tend to loosen. The chains should be crossed over the frame rather than under the frame to prevent slippage.

Never load drill carts on top of drills as seed-box damage will result.

When unloading drills without lifting equipment, use a bank, ramp or planks to prevent damage.

Do not permit roading of drills except for short distances and particularly not on a good road. Experience has shown that it is difficult for most people to keep down the speed and much damage can result. If roading is necessary, it must be properly supervised and a tractor should be used to maintain a slow speed.

SECTION X PLANNING & CONTOUR OPERATIONS

1. Planning

Indiscriminate seeding operations without serious thought to topographic, soil and climatic conditions can lead to soil deterioration through erosion and loss of structure. Well planned treatment practices must be developed and employed to insure means of preventing erosion, of improving soil structure and of improving moisture relationships.

Seeding jobs must be done in the most esthetically pleasing way possible. Where the job will be seen by a large segment of the public, this factor must be considered when planning the method of completing a particular job. When planning a seeding operation, make appropriate allowances for elimination of extended straight-line area boundaries so as to simulate a natural appearance.

2. Contour Operations

A basic, although often ignored, conservation principle in seeding is alignment of operations on the contour. Contour alignment, manifested in direction of travel, provides an effective and complementary attack on the forces of erosion. All seeding operations which disrupt the soil and influence runoff must be done on the contour. By applying seeding in such a manner, runoff will not be concentrated but will be obstructed. Contracts must include specifications concerning application of seeding on the contour whenever runoff is a problem.

3. Operating Efficiency

Adoption of a contour interval system of seeding operation will have a significant effect upon power requirements, fuel consumption, time of operation per unit area, and overall operating efficiencies.

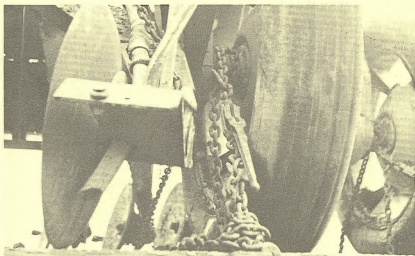


Figure 27. Proper chaining - it is important that two wraps of the chain be utilized.



Figure 28. Improper chaining

Studies have shown contour operations contribute to efficiencies in fuel consumption and operating time because of a faster and continuous rate of travel. Up and down grade operations lead to inefficiencies such as wheel slippage, stops for gear changes and tractor and implement wear and tear due to starts and stops.

4. Guide Rows

Contour operations should be aligned accurately if they are to be effective. Contour guide rows and project (job) boundaries will determine the pattern and accuracy of subsequent contouring operations. Hand leveling, when skillfully used and checked, is satisfactory for establishing contour guidelines and patterns.

SECTION XI RANGELAND DRILL INFORMATION

A. Parts Procurement

Custom-fabricated drill parts are stocked at the Forest Service Equipment and Service Depot, P. O. Box 70, 1611 Airport Way, Stockton, California 95801.

B. Maintenance

For information essential to the maintenance and operation of the drill, contact USDA Forest Service Equipment Development Center, 444 East Bonita Avenue, San Dimas, California 91773.

C. Service and Repair

Additional information on service and repair of rangeland drills may be obtained by contacting the

Bureau of Land Management
Vale District Office
365 "A" Street West
P. O. Box 700
Vale, Oregon 97918

D. Specifications:

Specifications for the rangeland drills are available from the USDA Forest Service Equipment Development Center, 444 East Bonita Avenue, San Dimas, California 91773.

E. Purchasing Procedures

For information on purchasing procedures, contact the USDA Forest Service Division of Operation, Region 5, 530 Sansome Street, San Francisco, California 94111.

